



Wir schaffen Wissen – heute für morgen

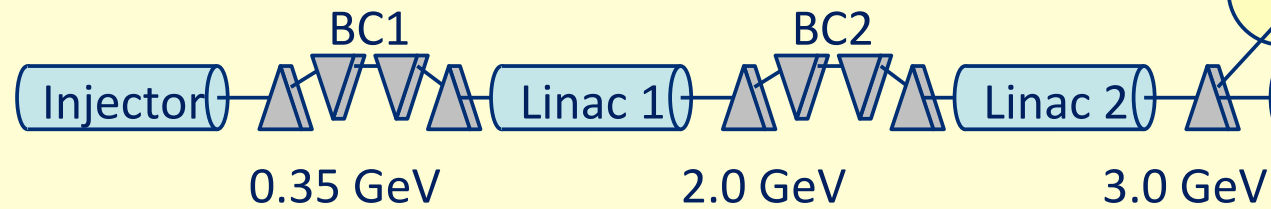
# Overview of the SwissFEL Project at PSI

Markus Janousch for Controls and the SwissFEL teams of PSI

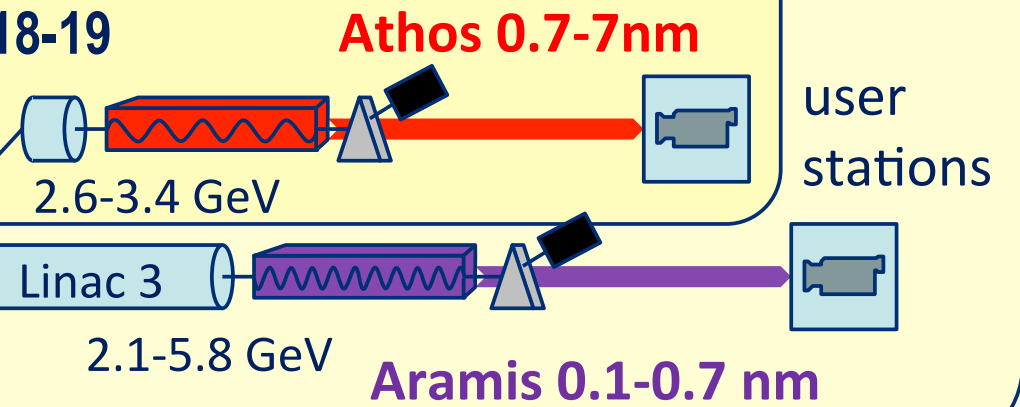


# Overview and Location

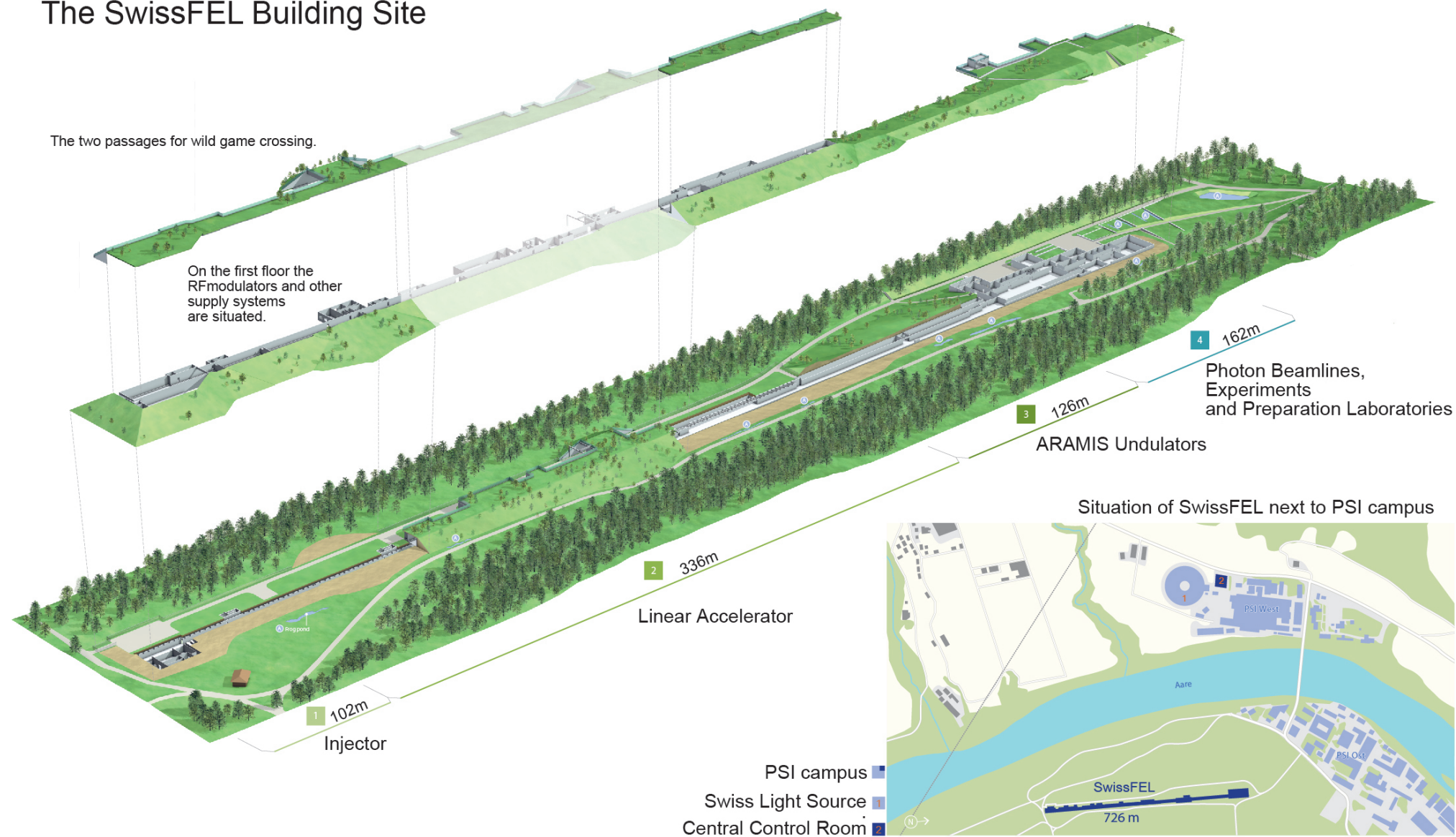
## 1<sup>st</sup> construction phase 2013-16



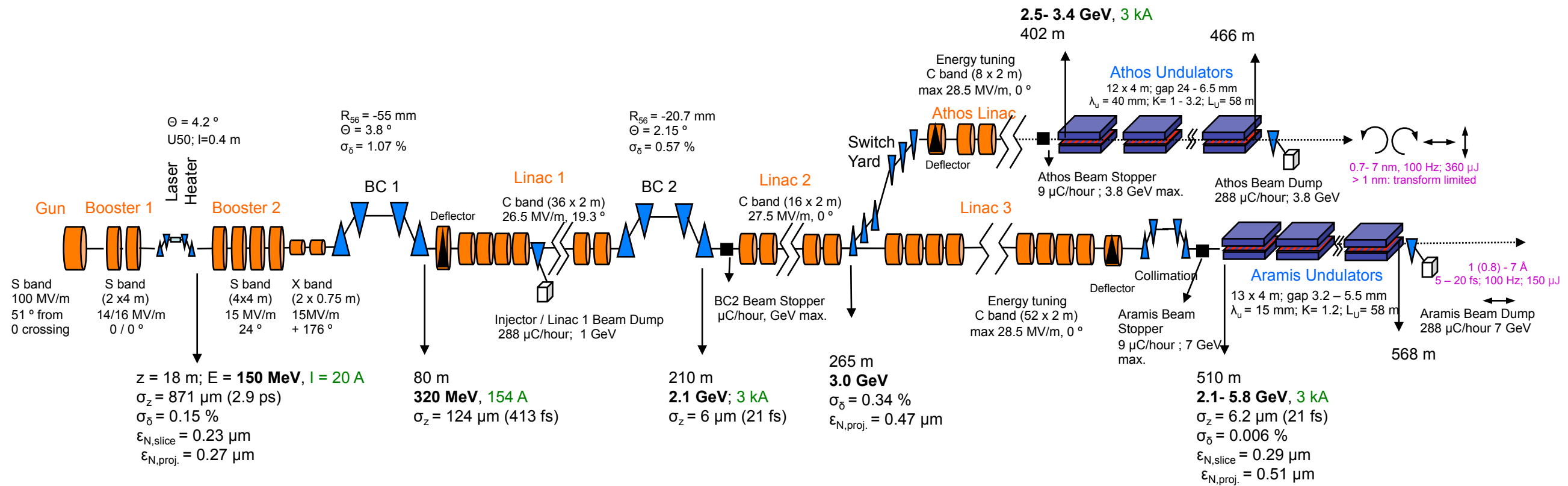
## 2<sup>nd</sup> construction phase 2018-19



## The SwissFEL Building Site



# Key Parameters

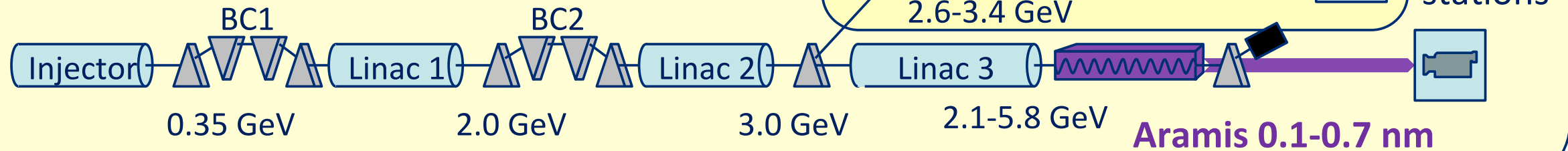


Overall Length	720 m
Total electrical power	5.2 MW
Maximum electron beam energy	5.8 GeV
Number of FEL lines	2
Wavelength	1 - 7 Å, 7 - 70 Å
Repetition Rate	100 Hz

Aramis 1 Å	Long Pulses	Short Pulses
Charge per Bunch	200 pC	10 pC
Bunch length	25 fs	6 fs
Peak Brightness	$7 \cdot 10^{32}$ ph/s/mm <sup>2</sup> /mrad <sup>2</sup> /0.1%	$1 \cdot 10^{32}$ ph/s/mm <sup>2</sup> /mrad <sup>2</sup> /0.1%
Number of Photons	$73 \cdot 10^9$	$1.7 \cdot 10^9$

# Overview and Schedule

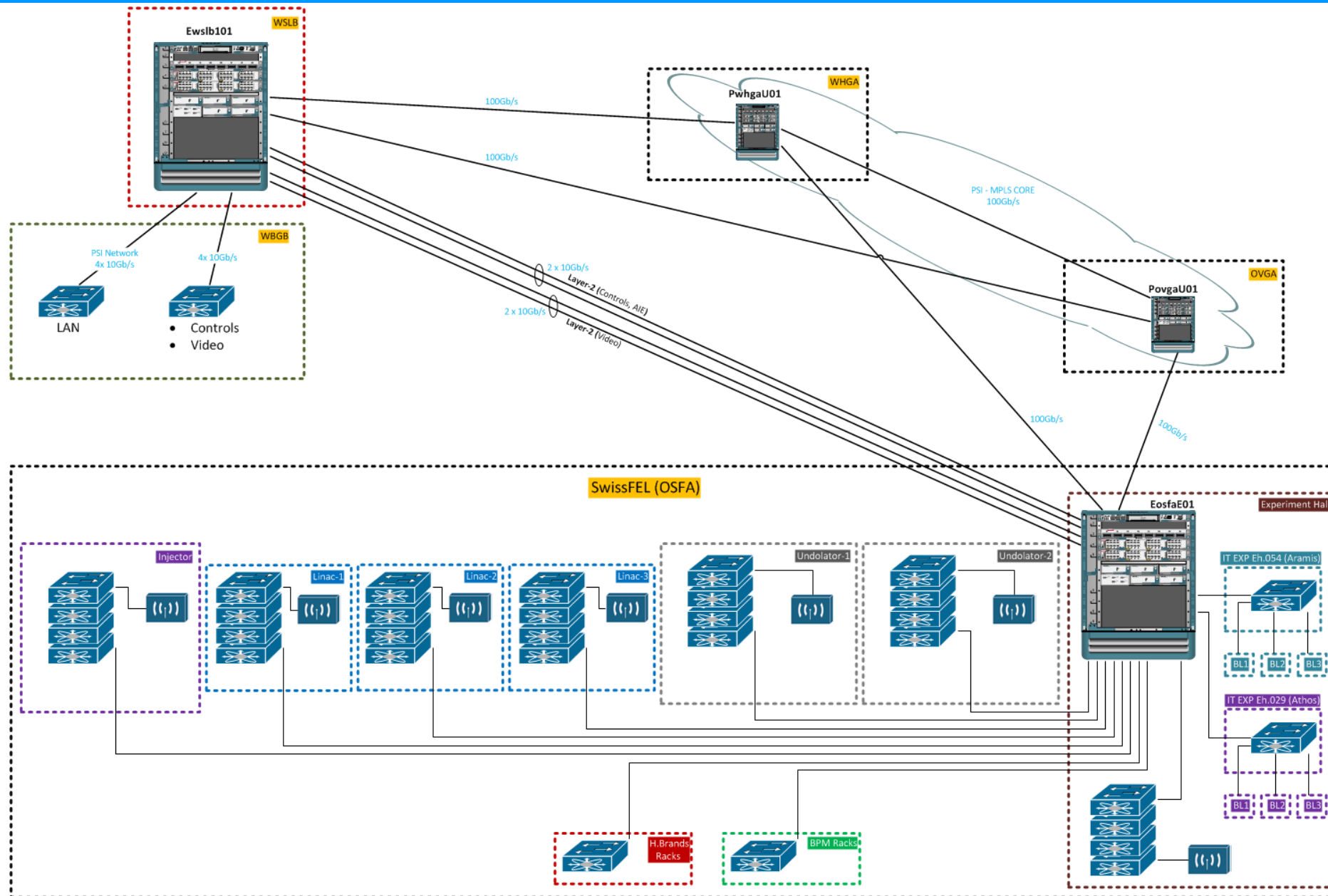
## 1<sup>st</sup> construction phase 2013-16



	2014	2015	2016	2017	
Injector	civil constr. & infrastr.	Injector installation	Inj. Com.	Commissioning	Pilot experiments
Undulator-lab	civil constr. & infrastr.	Undulator assembly & measurement			
RF gallery	civil construction & infrastructure	klystron modulators 1-13	modulators 14-26		
Linac & FEL tunnel		accelerator & FEL	Commissioning		
Photon beamlines		Photon-beamline	Commissioning		
Experiments		ESA &ESB installation	Commissioning		



# Network (provided by Central IT)



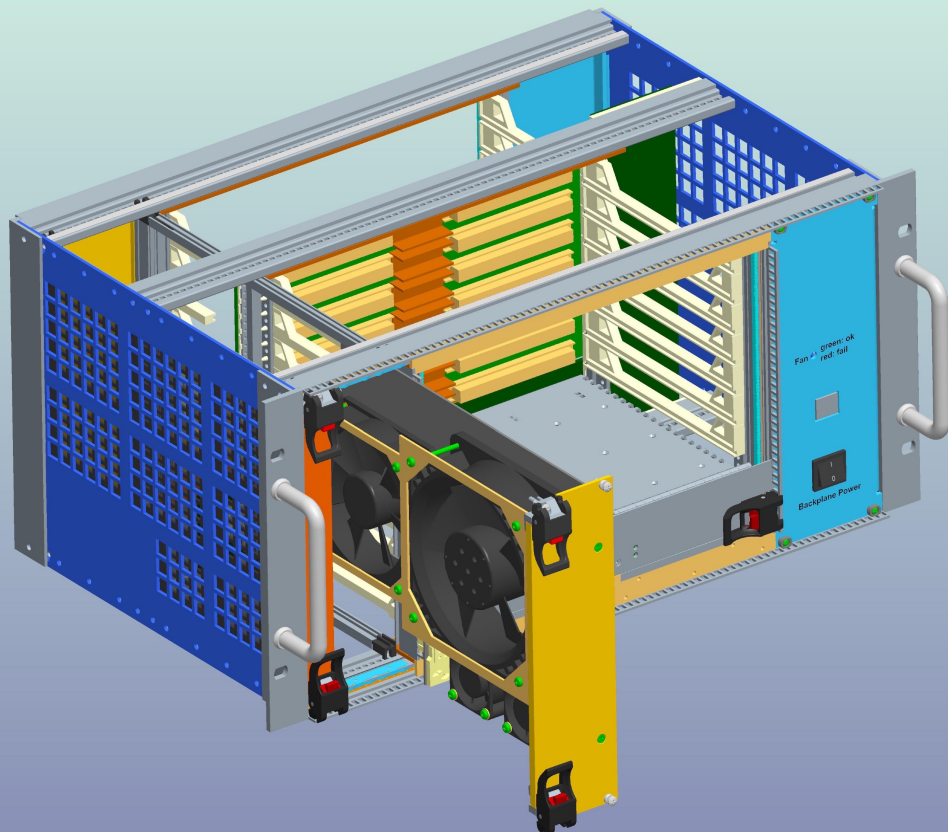
- 100 Gbit between SwissFEL, Control Room, and Computing Centers
- LAN, 10 Gbit SwissFEL, special devices
- WLAN in tunnel



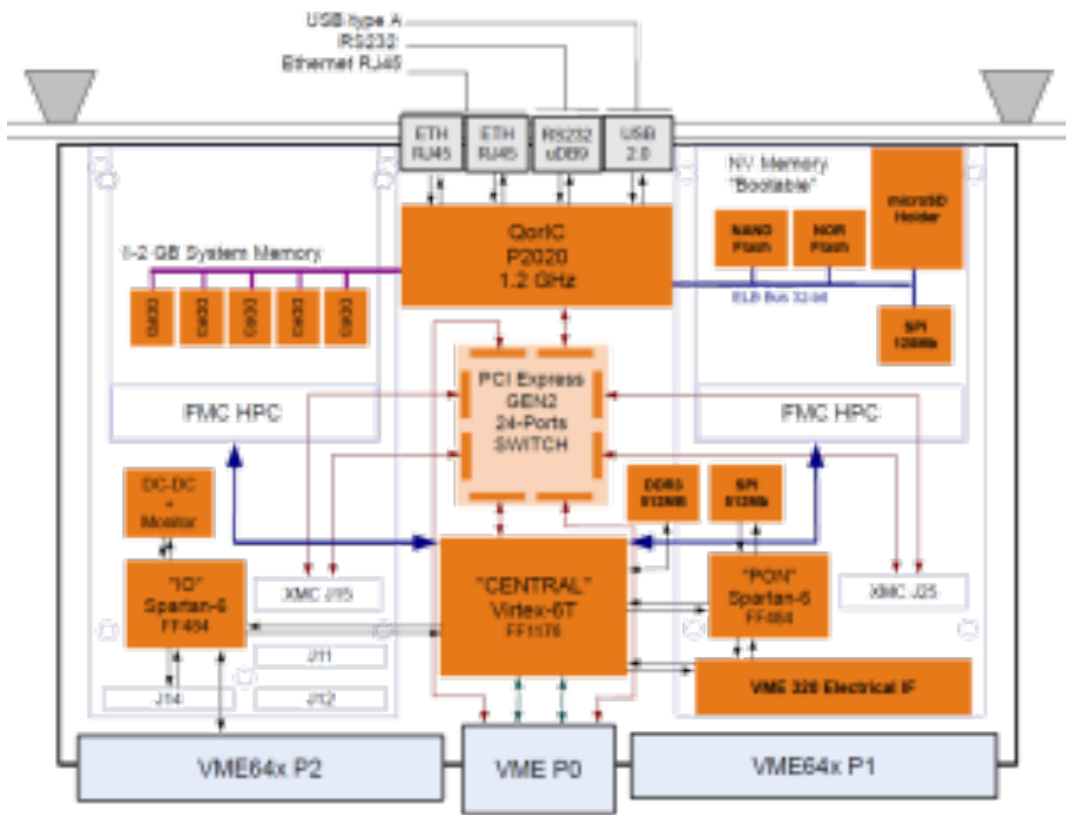


## 7-Slot VME Crates provided by Trenew

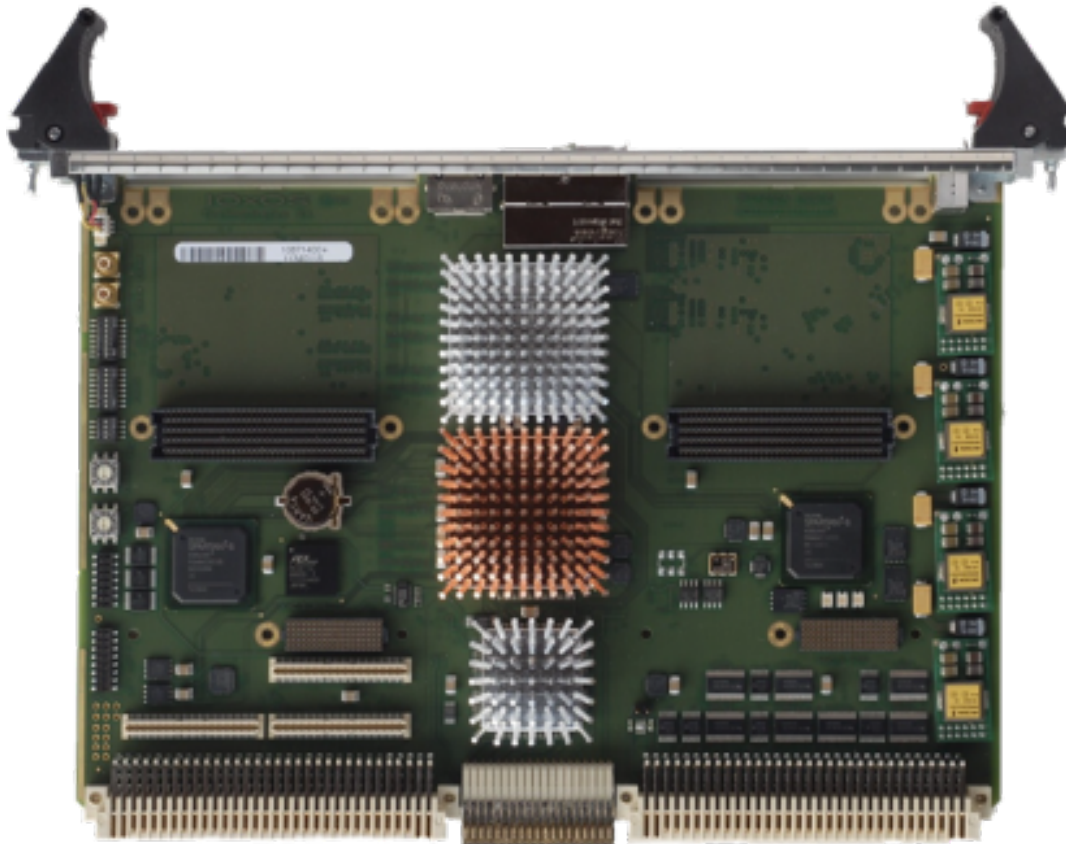
- Dual power supplies in parallel operation
- Cooling from side to side for improved airflow
- Plug-in power supplies, fan units, air filter etc. for easy maintenance
- Integrated crate monitoring with Ethernet connection (I<sup>2</sup>C)







see [http://www.ioxos.ch/images/pdf/01\\_datasheet/IFC\\_1210\\_DS.pdf](http://www.ioxos.ch/images/pdf/01_datasheet/IFC_1210_DS.pdf)



Co-developed by Controls, LLRF, and IOxOS Technologies SA in Switzerland.

6 U VME64x single board computer  
(Freescale Power PC P2020 dual core, Xilinx Virtex-6 central and Spartan-6 IO FPGAs).

## Extension slots

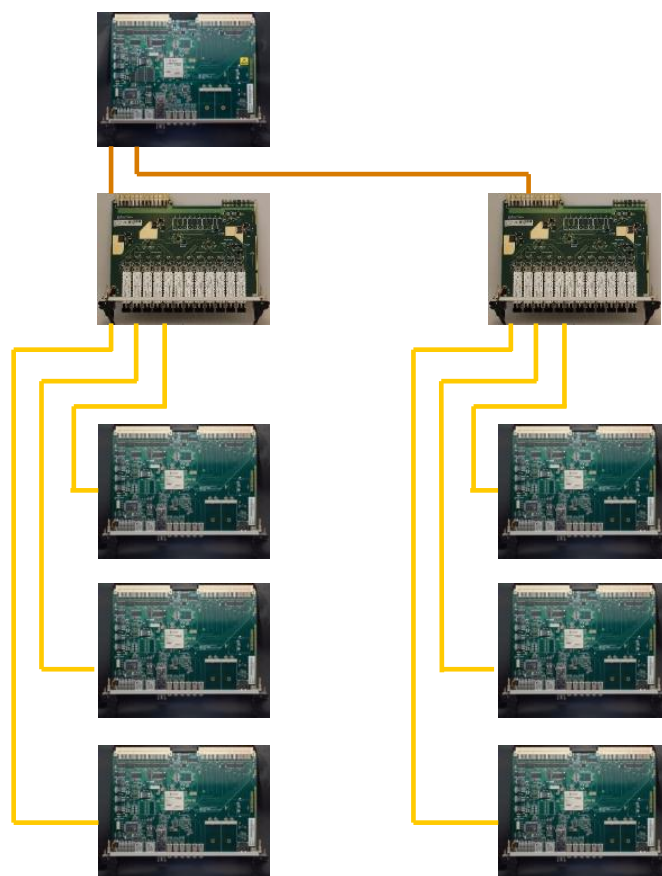
2 XMC, 1 PMC, 2 FMC mezzanine

## Operating system

Linux RT

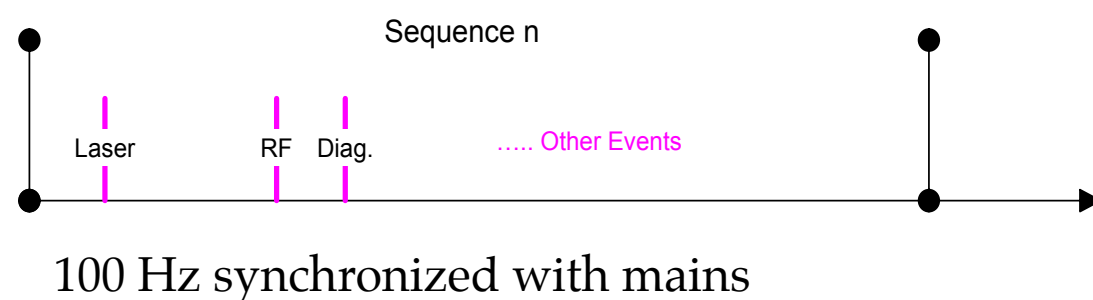
The board of choice for fast D/A signal processing, timing, Power-Supply control and connection to EtherCAT-Systems.

# Timing and Event System from MRF



- Reference clock runs at 142.8 MHz
- 5 ps RMS jitter
- Sequence reprogrammable within 10 ms (10 Hz)

## Event Sequencing:



New version of mrfioc2-driver developed with help of Cosylab. Also for PCIe.

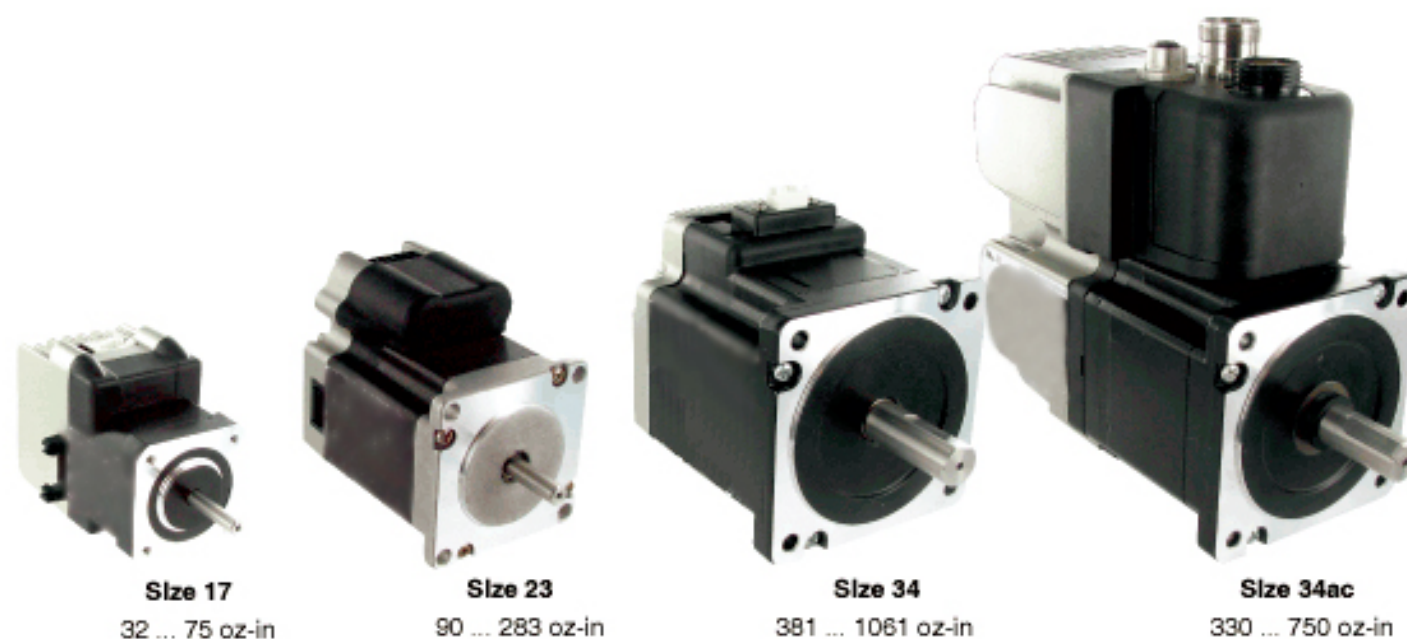




PowerBRICK LV IMS PSI based on Delta Tau's PowerPMAC.

PCIe timing card from MRF integrated.

For coordinated and synchronized movements.



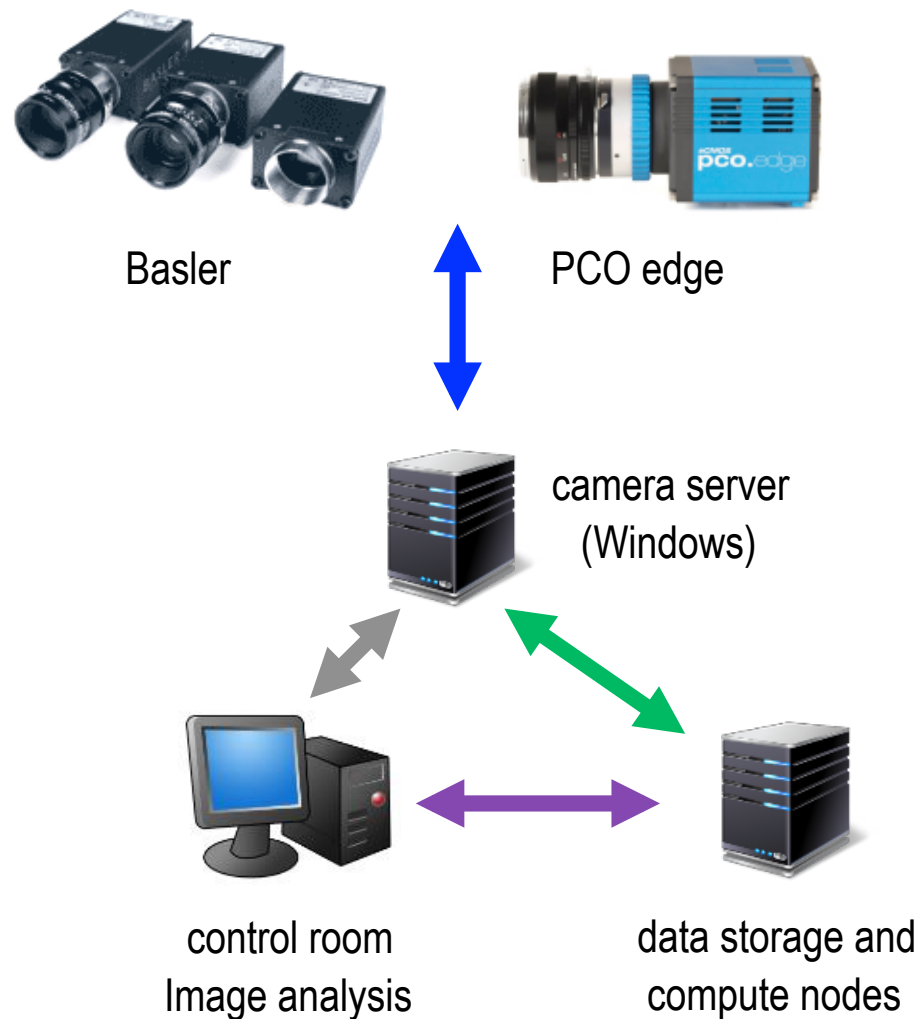
MDrive from Schneider-Electric

Ethernet communication interface

Incremental, SSI, and BISS encoders. A few special systems have to be supported.

New support of motorRecord for PowerPMAC written with help of Cosylab.

# Camera Support

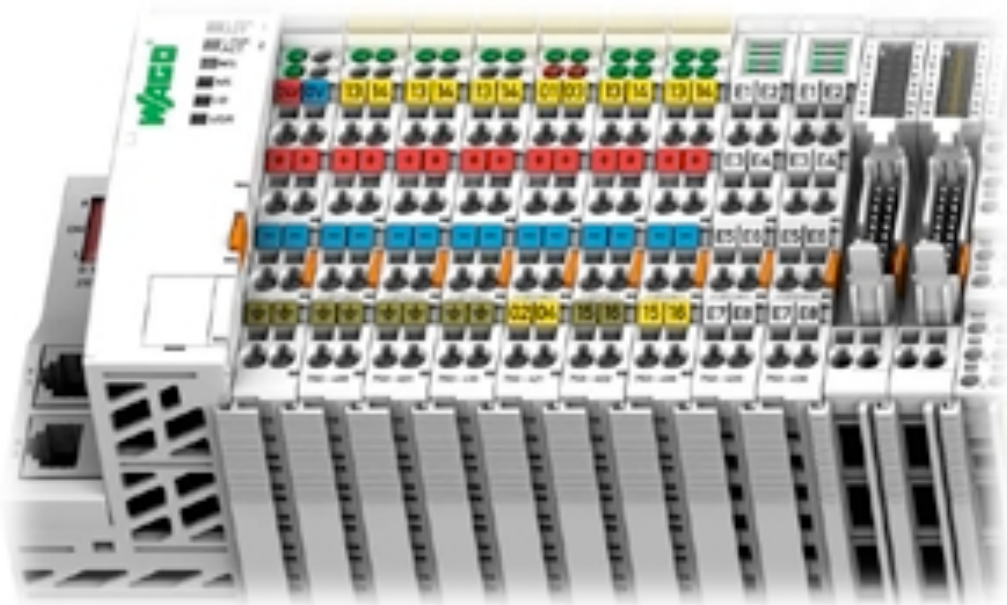


Cameras are used for

- Electron beam diagnostics
  - Lasers
  - Photon beam diagnostics
  - Experiments
- 
- MS Windows based system
  - Timing system (MRF) included
  - Fast analysis of data with 100 Hz
  - Dedicated storage for 5 cameras running simultaneously.



# Serial and Low Demand Systems



<http://www.wago.us/>

Serial and slow signals do not need VME

## **WAGO system**

Slow digital I/O

Slow analog I/O

Temperature measurement with low accuracy

Connected with Ethernet to an EPICS softIOC



[http://www.moxa.com/product/NPort\\_6650.htm](http://www.moxa.com/product/NPort_6650.htm)

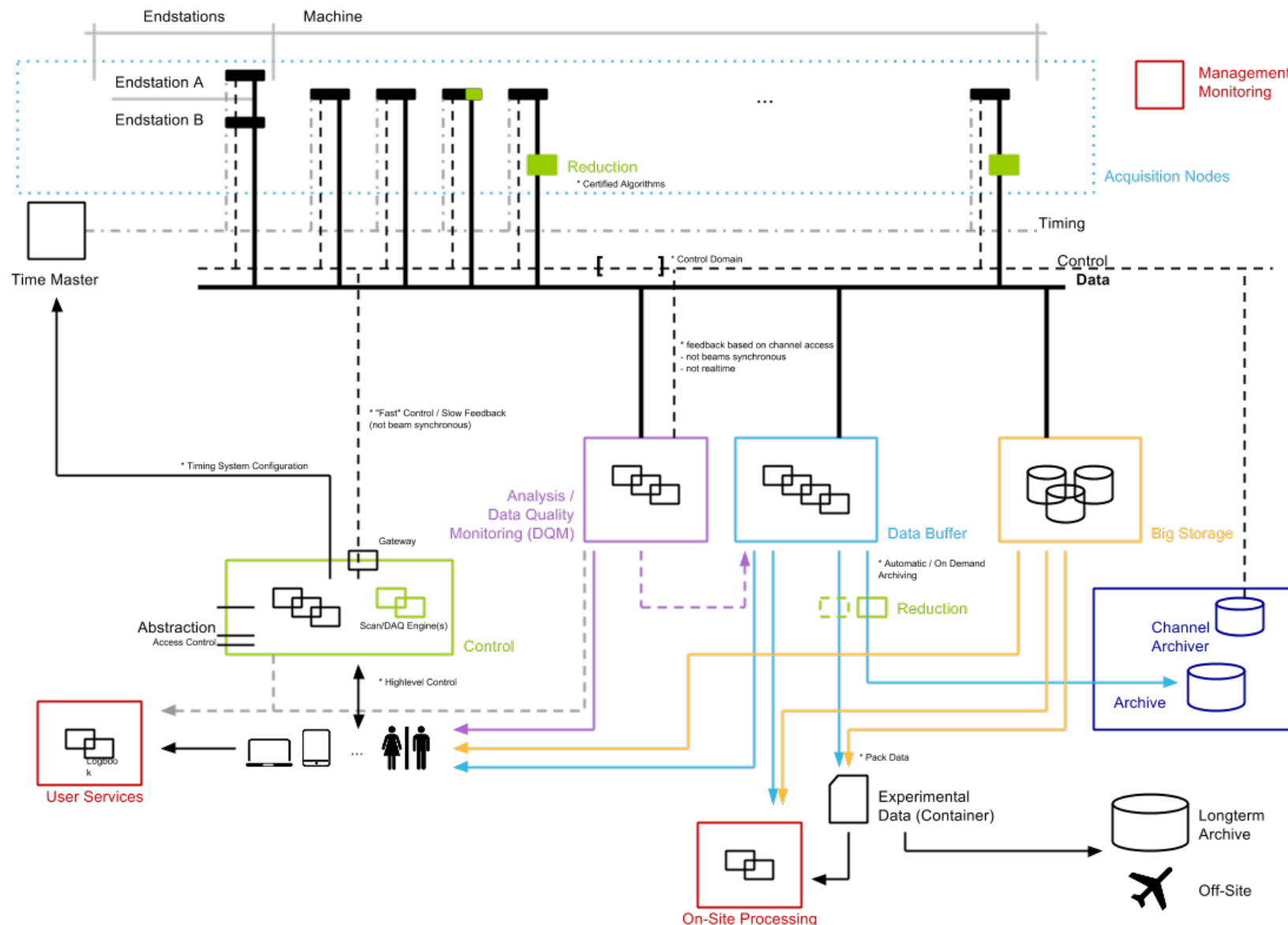
## **MOXA Serial Server**

16 serial ports

(configurable RS232, RS485, RS422)

Runs Linux and EPICS softIOC on the device

# Beam Synchronous and High Volume DAQ



Based on EVR or FPGA decoding of events.

## CA or JSON for configuration

## Streaming of data with ZMQ

## Storage of data in HDF5 format

Collected 20 TByte of camera data (Gigafrost) and 40 TByte of reconstructed data in 1 hr at TOMCAT (1Tb/min) beam line of SLS last month.



# Summary

- The hardware is available and has been tested. It is ready to be installed starting this summer.
- Many other new technologies are being developed and used and will be reported on a next meeting

<https://www.youtube.com/watch?v=6BtvzgYvrgk>